



CARNEGIE
SCIENCE

Carnegie Year Book

FISCAL YEAR JULY 2020 – JUNE 2021





CARNEGIE SCIENCE

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This is a selection of materials from our annual report, which
is online at: <https://yearbook.carnegiescience.edu/2021>.

A Message from Our President

This has been an exceptional year in the history of Carnegie Science. In the face of a global pandemic, our community has remained creative, resilient, and caring. We have made important discoveries, expanded our roster of exceptional scientists, and achieved crucial milestones to strengthen our Institution for years to come.

I am pleased that Margaret McFall-Ngai joined Carnegie as the Director of our new division in Pasadena. With her leadership we will build on Carnegie's long-standing expertise in exploring the natural world and pursue a new approach to asking big questions about the origins and development of life and its interdependencies with Earth's ecosystems—many of which are threatened by climate change.

Over the past year, we've welcomed several outstanding new Staff Scientists across our Institution: planetary atmosphere scientist Peter Gao, mineral physicist Anne Pommier, astronomer Ana Bonaca, marine and freshwater ecologist Elena Litchman, and global change scientist Jeffrey Dukes. We have also grown our Staff Associate program with three very talented, interdisciplinary early career scientists: engineer and ecologist Lorenzo Rosa, who advances climate change mitigation strategies across food, water, and energy systems; microbial ecologist Emily Zakem, who investigates connections between microbial ecosystems, global biogeochemistry, and the climate system; and plant biologist Adrien Burlacot, who specializes in the bioenergetics of algal cells and plants. We should be proud that our international reputation enables us to continue to recruit some of the most talented and creative researchers in the world.

This organization has endured and flourished for more than a century because our founder understood the powerful results that can be achieved when great scientists have the freedom and resources to follow their curiosity. Our leaders have also understood that great institutions have the potential to define new fields of investigation and that they must seize new opportunities as they arise.



COURTESY DAMIEN JEMISON

Eric D. Isaacs

Sincerely,

A handwritten signature in dark ink, reading "Eric D. Isaacs". The signature is fluid and cursive, with the first name "Eric" and last name "Isaacs" clearly legible.

Eric D. Isaacs

New Faculty Will Bring Broad Range of Expertise to Global Ecology

New powerhouse scientific talent with broad expertise ranging from marine and freshwater biogeochemistry to terrestrial ecosystem science to climate change adaptation and mitigation are burnishing the already sterling reputation of Carnegie's Department of Global Ecology for addressing the most urgent questions surrounding the sustainability of the Earth System.

Four new faculty signed on to join the department in 2022, and one Carnegie Department of Plant Biology staff member recently assumed a new joint position.

"Carnegie scientists were involved in establishing the discipline of ecology in the early 1900s at our former Desert Laboratory in Arizona. In 2002, recognizing the urgency of climate change and the need to address the related challenges of safeguarding energy security, food security, water sustainability, and biodiversity, Carnegie established the Department of Global Ecology to bring together a transdisciplinary group of experts to tackle these challenges at the global scale," said Director Anna Michalak. "We are thrilled that the 20th anniversary of our founding has brought

us so much new talent and we are eager to welcome our new colleagues."

The new faculty come from a variety of disciplinary backgrounds, but their work is interwoven by a common thread of revealing how interactions between human activity and Earth's natural systems manifest themselves at regional to global scales. This understanding is critical for developing successful climate mitigation and adaptation strategies.

Elena Litchman joins the department from Michigan State University, where she was an MSU Foundation Professor of Aquatic Ecology. She studies phytoplankton, which form the foundation of the aquatic food chain, with a particular focus on how environmental factors, including climate change, influence microbial community structure.

"I'm excited to join Carnegie because it is such a great institution with a very different, forward-looking way of doing science," Litchman said.


Emily Zakem explores how marine microorganisms affect, and are affected by, the climate system at large scales. A member of Carnegie's prestigious early career Staff Associate program, she arrived from the University of Southern California, where she was a Simons Foundation Postdoctoral Fellow.

Another new Staff Associate, Lorenzo Rosa, joins Carnegie from the Institute of Energy and Process Engineering at the Swiss Federal Institute of Technology (ETH) in Zurich, where he was a postdoctoral fellow. His work aims to assess the potential benefits and unintended climate and environmental consequences of innovations engineered to satisfy the increasing global demands for energy, water, and food.

Evolutionary geneticist Moises Exposito-Alonso, who joined Carnegie's Department of Plant Biology as a Staff Associate in late 2019, was also granted a joint appointment at the Department of Global Ecology. He conducts large-scale ecological and genome sequencing experiments to understand whether and how plants will evolve to keep pace with a changing climate.

Lastly, Jeffrey Dukes joined the department in May from Purdue University, where he directed the Purdue Climate Change Research Center and was a professor in departments of Forestry & Natural Resources and Biological Sciences. His research elucidates how ecosystems respond to environmental pressures, including climate change and invasive species.

"I've been a huge fan of Carnegie since I first learned about it when I was in graduate school," Dukes said. "It's got an amazing culture and an amazing history in my field."



"The new faculty come from a variety of disciplinary backgrounds, but their work is interwoven by a common thread of revealing how interactions between human activity and Earth's natural systems manifest themselves at regional to global scales."

Revealing How Microbial Communities Shape Our Lives

COURTESY OF LESLIE KOYAMA AND LUCY O'BRIEN.

Since William Ludington's arrival at Carnegie's Department of Embryology in 2018, he has been aggressively pursuing breakthroughs in microbiome research—deploying a multitude of genetic, physiological, and mathematical approaches to understand the community ecology of our gut microbiome and how it affects our health, fertility, and even longevity.

The human microbiome is an ecosystem of hundreds to thousands of microbial species living within our gastrointestinal systems. The tremendous species diversity of these communities makes it challenging to elucidate how its various parts add up to a greater whole. In other words, to what extent do individual species influence our health and physiology, and to what degree are these impacts determined by interactions between the species present in our microbiomes?

Above: Image of fruit fly gut.

"The microbiome is like a classic Hollywood musical number starring bacteria and being filmed inside your gastrointestinal system—each dancer is doing something interesting, but it's only when the camera pulls back to see the whole company from overhead that you understand the magnitude of the piece," said Ludington. His lab uses various techniques and approaches to probe these myriad relationships and attempt to reveal how the microbiome functions as a collective unit.

In particular, the Ludington lab investigates the dynamics of microbial interactions using the fruit fly, *Drosophila melanogaster*. The fruit fly gut carries far fewer microbial species. Using these insects to understand species-species interactions in the gut microbiome could eventually drive improvements in precision medicine and guide the development of regenerative therapies.

“Knowing how an individual cell’s response to its environmental surroundings affects its evolutionary fitness... could enable microbiome engineering to improve human health, increase agricultural yields, protect freshwater resources, and more.”

In 2021, Ludington’s quest to answer big questions about our microbiome was recognized with two funding windfalls that will propel his work to a new level of excellence. He was named a recipient of nearly \$1 million over three years from the National Science Foundation and selected as one of 14 researchers to receive \$55,000 from the Research Corporation for Science Advancement for its inaugural *Scialog: Microbiome, Neurobiology, and Disease initiative*. Short for science + dialog, Scialog awards were sponsored by RCSA, The Paul G. Allen Frontiers Group, and the Frederick Gardner Cottrell Foundation.

His NSF-funded project, jointly led with Stanford University’s Kerwyn Huang, aims to combine cellular physiology and ecological theory to understand the link between the actions of single cells and their success in the gut microbial ecosystem. Knowing how an individual cell’s response to its environmental surroundings affects its evolutionary fitness in the microbial community would be a major advance in the field. It could enable



Johns Hopkins University rotation student Gemechu Mekonnen prepares an assay in the Ludington Lab.

microbiome engineering to improve human health, increase agricultural yields, protect freshwater resources, and more.

Understanding the role evolutionary principles play in microbiome communities could also help explain the microbiome’s profound impact on neurological health and function. Age-related loss of microbiome species diversity is associated with neurological disorders in fish, mice, and humans. Ludington and UCLA’s Nandita Garud hypothesize that the mechanism behind this neurodegeneration is evolutionary, rather than ecological. Their Scialog project could cause a fundamental shift in the approach to microbiome research by investigating relationships between genetic changes in the microbiome and age-related frailty.

When a Star Gets Too Close to a Black Hole

ESO, ESA/HUBBLE, M. KORNMESSER

Tidal disruption events, or TDEs, occur when a star gets too close to a supermassive black hole—objects with immense gravitational pull that are thought to lie at the center of most large galaxies. The black hole’s forces overwhelm the star’s gravity and tear it to shreds. Some of its material gets flung out into space and the rest falls back onto the black hole, forming a disk of hot, bright gas as it is consumed.

By observing the light given off during this process, which increases to a peak brightness and then tapers off, astronomers can better understand the physics of the black hole and the forces driving these violent encounters. Observatories NHFP Einstein Fellow Thomas Holoien leverages big data to study these fascinating phenomena, as well as supernovae and other so-called transient celestial events.

In 2019, Holoien made a major breakthrough when he led the research team that discovered ASASSN-19bt using the Ohio State University-based international network of telescopes of which he is a founding member called the All-Sky Automated Survey for Supernovae (ASAS-SN). The Holoien-led team then rapidly triggered follow-up observations of the newfound TDE using both space and ground-based telescopes, including NASA’s Transiting Exoplanet Survey Satellite (TESS). Catching the event in the act enabled the astronomers to garner the most complete picture of this type of violent occurrence taken to date.

Although it was long thought that all TDEs looked the same, the team—which also included Carnegie’s Decker French, Konstantina Boutsia, Thomas Connor, Nidia Morrell, Andrew Newman, and Gwen Rudie, as well as Carnegie-Princeton

“Active galaxies, such as the host of ASASSN-14ko, have unusually bright and variable centers. This partial TDE was the first unambiguous example of such clockwork behavior from an active galaxy.”

Fellow Rachael Beaton—found that ASASSN-19bt was unusual in several of ways.

Its host galaxy is younger and more dust-filled than has previously been observed for other TDE events. Secondly, it experienced a short blip of cooling and fading before its temperature leveled off and its luminosity continued to build toward its peak. This information has improved astronomers’ ability to identify these phenomena and differentiate them from other celestial events that have a much choppier emission of light.

Holoien’s TDE expertise advanced again in 2021 when he was part of a research team that revealed a case of cosmic mistaken identity.

They found that the discovery of a presumed supernova, called ASASSN-14ko, six years prior was actually periodic flaring from a galaxy more than 570 million light-years away where a supermassive black hole was giving off bursts of energy every 114 days as it tore off chunks of an orbiting star.

Active galaxies, such as the host of ASASSN-14ko, have unusually bright and variable centers. This partial TDE was the first unambiguous example of such clockwork behavior from an active galaxy. The flares occurred when the lost material—equal to three times the mass of Jupiter at each pass—falls in towards the black hole. This rare find could help them understand the physics of these mysterious phenomena.



COURTESY OF THE CARNEGIE INSTITUTION FOR SCIENCE

Illustration of a TDE by Robin Dienel.

Checking in with CASSI Alumni

The Carnegie Astrophysics Summer Student Internship Program (CASSI) lasts just ten weeks. But the experiences garnered by its participants during that short period ripple outward, influencing their professional aspirations and academic choices for years.

This intensive summer internship was created to prepare participants for success at school and in the future—regardless of whether they choose to pursue careers in academia or elsewhere after graduation.

Program Director Gwen Rudie, also a Staff Scientist at the Carnegie Observatories, designed the CASSI experience to impart skills that are imperative for success, especially those such as oral presentation abilities and scientific writing, which aren't typically taught in a classroom.

Alumni from a variety of academic backgrounds credit their CASSI experience with shaping their ambitions and contributing to their successes.

Above: Summer students Cayla Dedrick and Emmanuel Doradola are interviewed along with their mentor, Johanna Teske, for a news story on planetary science.

East Los Angeles College physics major Jandrie Rodriguez emphasized that her participation in the 2021 Observatories' summer student program taught her what to look for in a university environment when she's ready to transfer. This includes a commitment to diversity, equity, and inclusion and an understanding of the importance of setting boundaries, even as you work hard, she said.

"I don't have an academic advisor, so I had that experience for the first time at CASSI," she explained, noting that her mentor, former Carnegie postdoc Alexander Ji included her in all of his group meetings and built a working relationship with her based on mutual trust and respect. "It wasn't just 'do this for me' to get a letter of recommendation."

Two-time CASSI intern Beryl Hovis-Afflerbach said their work with Carnegie

postdoc Ylva Götberg introduced them to computational research and the ways that it can inform and be tested by observations. They also appreciated the chance to attend a professional conference—the American Astronomical Society’s annual meeting—and share their work.

“You really feel like you are part of the field as a whole,” they said. “It made it feel very purposeful to talk to other people whom I haven’t met before about the research I’ve been doing.”

Sal Fu, a Berkeley graduate student studying galaxy evolution on the smallest-known scales, was clear that her multi-year CASSI experience taught her that she enjoyed research enough to pursue an academic career beyond her undergraduate years. She added that her work at Carnegie with Observatories Staff Scientist Josh Simon influenced the subfield of astrophysics in which she chose to focus her graduate research and that she enjoys that her work still frequently brings her into contact with people from the Observatories.

2019 summer student Emmanuel Durodola, now a graduate student in astrophysics at Dartmouth University, also credited his mentor, Johanna Teske—then a Carnegie Observatories postdoc, now a Staff Scientist at Carnegie’s Earth and Planet’s Laboratory—with helping him realize that he could pursue an advanced degree.

“It was the first time I could talk to a professional in the field about their day-to-day

experiences and figure out what was of the greatest interest to me,” he said.

Durodola particularly appreciated the sense of collegiality among scientists of all career stages at the Observatories, including the internship participants.



Carnegie summer interns enjoy a night out with Observatories staff at Dodger's stadium.

“Carnegie is really a unique place in that way,” he added. “This culture was a huge factor in my decision to apply to graduate school, especially the encouragement of Johanna and Gwen.”

Fu had similar praise for Rudie’s leadership of the program and accessibility to interns long after the summer’s programming concluded.

“She’s just been such an amazing champion for me in all the ways that I really needed,” Fu said.

“Her commitment is real and genuine and has played out in really important ways for me.”

Donor Stories

For the full FY21 donor recognition list please visit
<https://yearbook.carnegiescience.edu/2021>.

Supporting Women Scientists

Marguerite “Margo” Kingston

“I first heard about Carnegie Science during my work at the US Geological Survey. I noticed early on that the science labs at Carnegie were ahead of their times, especially in supporting women. And today the Institution continues to enrich its staff with women scientists in the Earth, space, and the life sciences.

The fame of this research Institution and its staff attract many outstanding candidates. I am most familiar with the Earth and Planets Laboratory. Here, researchers are not burdened with classroom teaching, but are mentors for enthusiastic post-doctoral scientists.

These are just a few examples of why it is important to me to contribute to Carnegie Science. My contributions are small but my regards for the Institution are huge. For over a century, they have continued to support amazing scientific research in a collegial atmosphere. And it is a great place for all scientists to work in!”



Marguerite Kingston has been supporting Carnegie Science for many years. See her full video testimonial at <https://yearbook.carnegiescience.edu/2021>.

Opening Doors

Dr. Jo Ann Eder

Dr. Jo Ann Eder took an unconventional path to her degree in astronomy. As someone who recognizes that there is more than one route to academic success, she is dedicated to ensuring opportunities in science for historically underrepresented groups. To advance this priority, she established a fund to support Carnegie postdocs from underrepresented communities.

After raising 10 children with her husband, Bert, all homeschooled with a strong emphasis on science and the natural world, Eder determined that she wanted to pursue an advanced degree of her own. "I thought to myself: I don't want to wake up one day when I am older and wonder why I never tried to pursue astronomy," Eder explained.



But having been out of the professional and educational fields for a number of years, she faced many rejections due to the "gap" on her resume. It wasn't until she applied to Yale's astronomy program that she was accepted and able to begin her studies again. At Yale, there had been several women with similar backgrounds to Eder's who had come before her and understood her situation. Eder feels grateful for these mentors and colleagues, who both helped pave the way for her and enabled her to bring her dream to fruition. Now, through her giving to Carnegie Science she wants to create opportunities for others.

After completing her Ph.D., Eder was a postdoc at what is now Carnegie's Earth and Planets Laboratory from 1990 to 1992 and went on to conduct research at the National Astronomy and Ionosphere Center in Puerto Rico, where she studied dwarf galaxies, among other objects. She has maintained a relationship with Carnegie ever since.

"I feel passionately about the power of nonprofits to bolster healthy communities and make the world a better place," Eder said. This is why she donated to establish the Postdoctoral Support for Underrepresented Communities, which will promote diversity within the Earth and planetary sciences.

We are grateful for her generosity and proud to have such an accomplished and driven woman as a member of our Carnegie community of alumni and friends.

Jo Ann Eder is a long-time donor and friend to Carnegie Science. From 1990–1992 she was a postdoctoral fellow at what is now Carnegie Science's Earth and Planets Laboratory. She currently lives in Montana with her husband, Bert.

DONOR STORIES

Exploring the Night Sky

Christopher and Lois Madison

On one of their first dates, Chris Madison brought his wife Lois outside to look at the Moon and describe its phases. Seeing the wonder and passion he had for the night sky, Lois sensed that astronomy and the stars would always play some role in their relationship.

Chris's love of astronomy first emerged when he was a boy. He and his father both struggled with insomnia, so they made the best of the situation and spent time outdoors together late at night, snacks in hand, gazing at the stars. Through those experiences, Chris fell in love with the night sky and wanted to learn as much as he could about the universe.

The Madisons were introduced to Carnegie Science through a friend who invited them to attend a lunch program at the Observatories in Pasadena. As a result of this connection, they joined a community that enjoys exploring and thinking about the cosmos and our place in it. Through various events and gatherings, they met other like-minded enthusiasts, spoke with Carnegie scientists, and made new friends and acquaintances.

Then, a few years ago, an ambitious new idea for an instrument to be used on Carnegie's Magellan telescopes at our Las Campanas Observatory in Chile was put forth by several Carnegie staff scientists, Nick Konidaris, Gwen Rudie, and Drew Newman. The instrument, known as the Magellan Multi-object Spectrograph (MIRMOS), will enable astronomers to collect spectra from distant galaxies and other objects simultaneously. That data will contribute significantly to addressing extragalactic, cosmological, and exoplanetary science questions.



"This project is ambitious, creative, and at the leading edge of what we think we can do," Carnegie Observatories Director John Mulchaey said. "When I thought of people who might share our imagination and who might be able to help, I knew that I wanted to speak with Chris and Lois about the project." Soon after learning about the goals of MIRMOS, Chris and Lois decided to make a gift that would significantly advance MIRMOS into prototyping and completion.

Chris hoped that his philanthropy would inspire others to support organizations and causes about which they are passionate. He had looked up at the stars as a child with amazement, and his wonder grew into a love for astronomy that stayed with him throughout his life. Everyone at the Carnegie Observatories will remember him fondly.

In Memoriam: Since participating in an interview for the Yearbook, Chris Madison passed away in March 2022. We are deeply grateful for his dedication to Carnegie Science and sorely miss his friendship and camaraderie.

Honors and Awards

Carnegie's Van Keken Elected AGU Fellow

Carnegie geophysicist and geodynamicist Peter van Keken, whose work reveals Earth's thermal and chemical evolution, was elected a Fellow of the American Geophysical Union in 2021. The cohort was chosen for their "outstanding achievements and contributions by pushing the frontiers of our science forward," according to AGU, as well as for embodying the organization's "shared vision of a thriving, sustainable, and equitable future for all powered by discovery, innovation, and action."

Carnegie's Exposito-Alonso Receives NIH Director's High-Risk, High-Reward Program Award

In October 2020, Carnegie's Moises Exposito-Alonso was selected for a National Institutes of Health Director's Early Independence Award, which recognizes "outstanding junior scientists" for their "intellect, scientific creativity, drive, and

maturity." The honor is part of the NIH's High-Risk, High-Reward Program, designed to fund highly innovative, potentially transformative biomedical and behavioral research at all career stages.

Carnegie's Hazen Elected Fellow of Only Professional Society Dedicated to Origins of Life Research

In November 2020, Carnegie mineralogist Robert Hazen—who advanced the concept that Earth's geology was shaped by the rise and sustenance of life—was elected a fellow of the International Society for the Study of the Origin of Life – The International Astrobiology Society. It is the only professional society dedicated to origins research and its 500 members represent disciplines ranging from molecular biology to astronomy.

Carnegie Scientist Michalak Awarded AGU Simpson Medal

Carnegie Department of Global Ecology Director Anna Michalak

was honored in 2021 with the American Geophysical Union's Simpson Medal. Each year, AGU—a professional society of more than 130,000 experts in the Earth and space sciences—selects two or three members "who have made transformative scientific advances or breakthroughs in the Earth and space sciences, have demonstrated strong leadership, and provided outstanding service to science and society" for this recognition.

Carnegie's Shahar Honored by American Geophysical Union

Carnegie geochemist Anat Shahar, who probes the formation, evolution, and interior dynamics of Earth and other rocky planets, was selected to give the Reginald Daly Lecture at the American Geophysical Union's 2021 annual Fall Meeting. In honor of its namesake's contributions to understanding the forces that shaped our planet, recipients for this recognition are selected for exemplifying excellence in the geosciences.

The complete 2021 annual report is online at <https://yearbook.carnegiescience.edu/2021>.

Financial Profile

for the year ending June 30, 2021

The complete audited financial statements will be made available on our website at <https://yearbook.carnegiescience.edu/2021>

READER'S NOTE: In this section, we present summary financial information. Each year the Carnegie Institution, through the Audit committee of its Board of Trustees, engages an independent auditor to express an opinion about the financial statements and the financial position of the Institution. The complete audited financial statements are made available on our website at www.carnegiescience.edu.

The Carnegie Institution for Science completed fiscal year 2021 in sound financial condition after generating a net return of 32.6% on the diversified investments within its endowment; maintaining a disciplined spending policy that balances today's needs with the long-term requirements of the institution and the interests of future scientists; and the continued support of organizations and individuals who recognize the value of basic science.

The primary source of support for the institution's activities continues to be its endowment. This reliance on institutional funding provides an important degree of independence in the research activities of the institution's scientists.

As of June 30, 2021, the endowment was valued at \$1.16 billion. Over the period 1998–2021, average annual distributions from the endowment to the budget were 5.0%. Carnegie closely controls expenses to ensure the continuation of a healthy scientific enterprise.

For several years, under the direction of the Investment Committee of the Board, Carnegie's endowment has been allocated among a broad spectrum of asset classes including: global equities, absolute return investments, real estate partnerships, private equity, venture capital, natural resources partnerships, and government bonds. The goal of this diversified approach is to generate attractive overall performance and reduce the volatility that would exist in a less diversified portfolio. In 2016 Carnegie hired its first Chief Investment Officer to more proactively steward the endowment's assets.

The Chief Investment Officer and Investment Committee regularly examine the asset allocation of the endowment and readjust the allocation, as appropriate. The institution relies upon external managers and partnerships to conduct the investment activities, and it employs a commercial bank to maintain custody. The following chart shows the allocation of the institution's endowment among asset classes as of June 30, 2021.

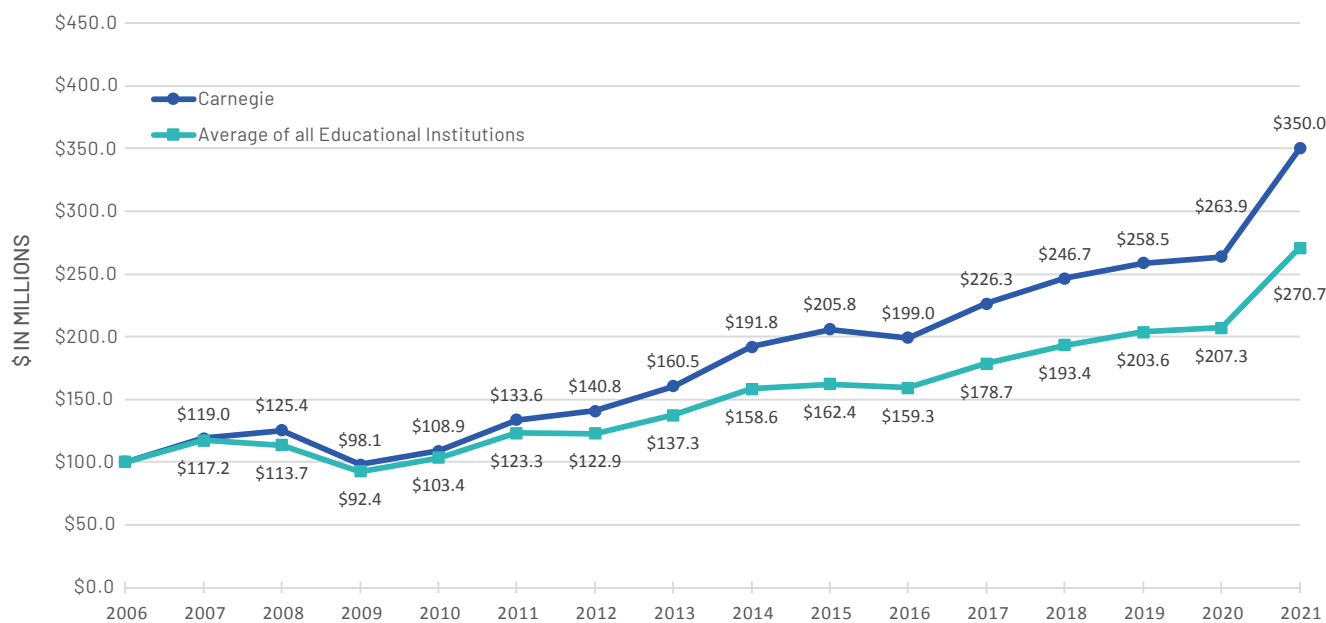
ASSET CLASS	TARGET	ACTUAL
Common Stock	45.0%	43.3%
Alternative Assets	43.0%	47.2%
Fixed Income and Cash	12.0%	9.6%

This chart shows the allocation of the institution's endowment among asset classes as of June 30, 2021.

Carnegie's investment goals are to provide high levels of current support to the institution and to maintain the long-term spending power of its endowment. The success of Carnegie's investment strategy is illustrated in the following figure that compares, for a hypothetical investment of \$100 million, Carnegie's investment returns with the average returns for all educational institutions for the last fifteen years.

\$100 Million Investment

Carnegie Returns vs. Average of all Educational Institutions (2006-2021)

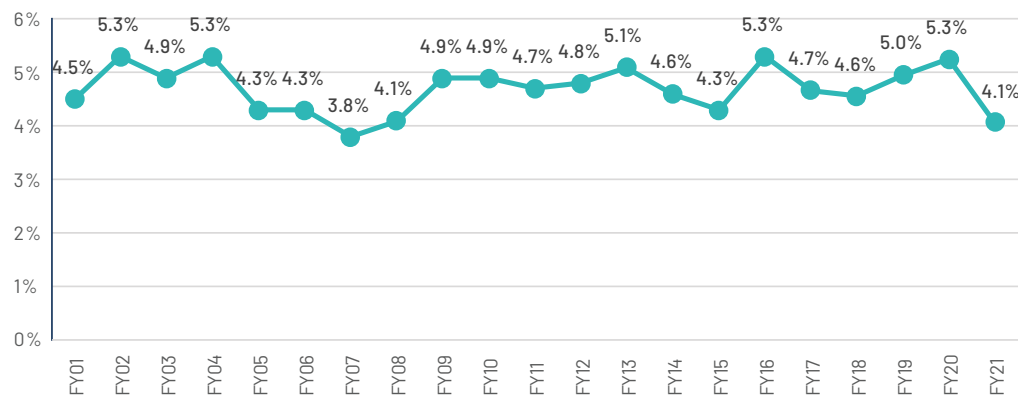


FINANCIAL PROFILE

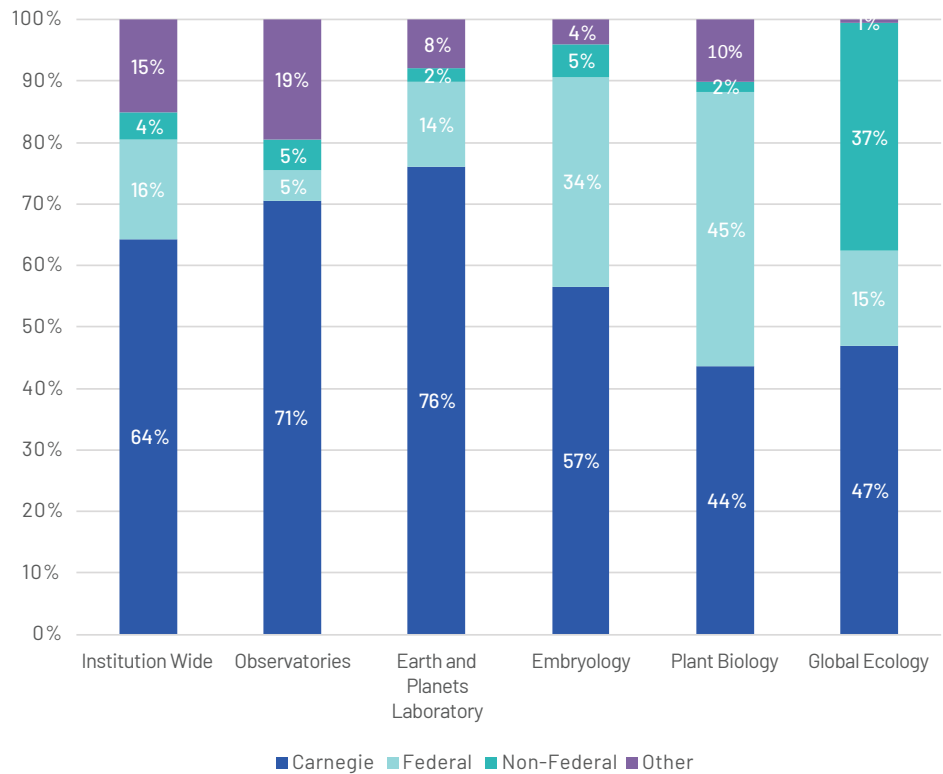
Carnegie has pursued a long-term policy of controlling its spending rate by using a hybrid spending rate, which in the long term contributes 5% of the endowment for annual use. Carnegie employs what is known as a 70/30 hybrid spending rule. That is, the amount available from the endowment in any year is made up of 70% of the previous year’s budget, adjusted for inflation, and 30% of the most recently completed year-end endowment value, multiplied by the spending rate of 5% and adjusted for inflation and debt. This method reduces volatility from year-to-year. The following figure depicts actual spending as a percentage of ending market value for the last 20 years.

In fiscal year 2021, Carnegie benefitted from continuing support from federal and non-federal/ private grants for specific research purposes. These types of funds make up more than 20% of Carnegie’s operating budget. This is a testament to the high quality of Carnegie scientists and their ability to compete successfully for federal funds.

Endowment Spending as Percentage of Endowment Value



Expenses by Funding Type By Department



Within Carnegie’s endowment, there are several “funds” that provide support either in a general way or targeted to a specific purpose. The largest of these is the Andrew Carnegie Fund, begun with the original gift of \$10 million. Mr. Carnegie later made additional gifts totaling another \$12 million during his lifetime. This tradition of generous support for Carnegie’s scientific mission has continued throughout our history.

Statement of Financial Position

July 30, 2021 and 2020 (in thousands)

ASSETS	2021	2020
Cash and Cash Equivalents	\$ 36,238	\$ 30,125
Contributions Receivable	3,571	3,728
Accounts Receivable and other assets (net)	7,807	9,265
Bond Proceeds	54,817	120,582
Investments	1,173,771	917,741
Property and equipment (net)	108,591	118,276
Assets held for sale (net)	7,056	
Long term deferred asset	61,596	61,596
Total assets	\$ 1,453,447	\$ 1,261,313

LIABILITIES		
Accounts payable and accrued expenses	10,262	11,403
Deferred revenue	26,500	28,587
Bonds payable	148,851	214,348
Accrued Postretirement benefits	31,650	32,741
Total liabilities	217,263	287,079

NET ASSETS		
Without donor restriction	362,758	311,622
With donor restriction	873,426	713,146
Total net assets	1,236,184	1,024,768

Total liabilities and net assets	\$ 1,453,447	\$ 1,261,313
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To see the complete 2021 annual report, please go online and visit <https://yearbook.carnegiescience.edu/2021>.

Statement of Activities

July 30, 2021 and 2020 (in thousands)

REVENUE AND SUPPORT	2021	2020
Grants and contracts	\$ 16,903	\$ 17,668
Contributions, gifts	4,627	4,493
Other Income	4,112	2,358
Net external Revenue	25,642	24,519

Investment income and unrealized gains	321,687	17,816
Total Revenue	\$ 347,329	\$ 42,335

EXPENSES		
Program and Supporting Services:		
Observatories	22,590	24,078
Earth & Planets Laboratory	20,303	22,083
Embryology	13,772	13,471
Plant Biology	9,523	9,173
Global Ecology	3,041	4,792
Other Programs	821	278
Administration and general expenses	17,391	14,416
Total Expenses	\$ 88,291	\$ 88,291

NET ASSETS		
Change in net assets before pension related changes	259,888	(45,956)
Pension related changes	2,890	(3,649)
Other components of postretirement benefit expense	(828)	(929)
Grant modifications	—	—
Net Assets at the beginning of the period	974,234	1,024,768

Net assets at the end of the period	\$ 1,236,184	\$ 974,234
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On the Horizon

Andrew Carnegie founded our institution in 1902 as a home for world-transforming scientific discoveries. Today, Carnegie Science's mission—to advance investigation, research, and discovery, and apply that knowledge to the improvement of humankind—is more urgent than ever.

We are now entering a time of scientific discovery unparalleled in our history. This new age brings a convergence of trends in scientific practice and technology that allows interdisciplinary research to thrive. New instrumentation and technologies, such as next-generation massive telescopes and gene-editing tools like CRISPR, are opening entirely new fields of research. And incredible advances in computation are revealing deeper and ever-more-complex opportunities for insight. Our growing partnership with Caltech, including significant collaborations on the technology driving 21st-century science, is accelerating our ability to capitalize on this pivotal moment.



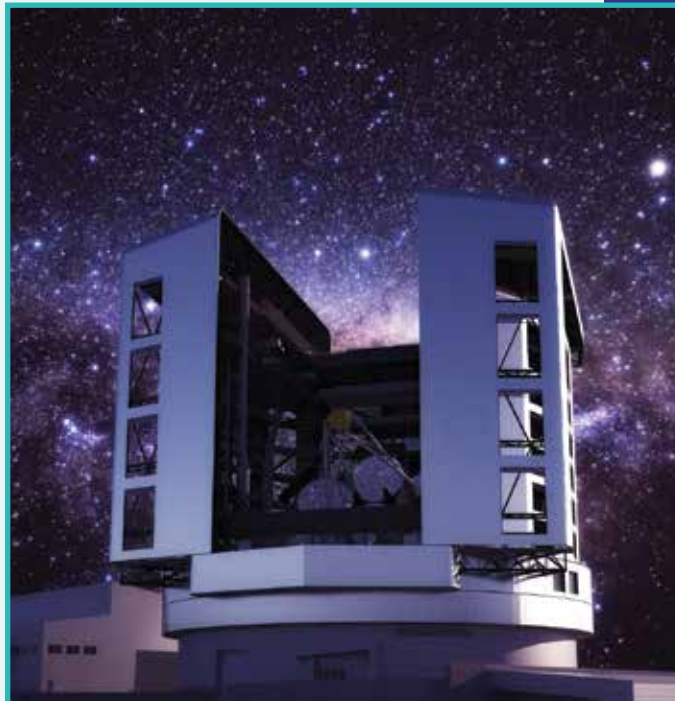
Toward a New Era in Astronomy and Astrophysics

In November 2021, the National Academies of Sciences, Engineering, and Medicine ranked the U.S. Extremely Large Telescope program as a top strategic priority, recommending federal support for the final construction stages of the Giant Magellan Telescope, which is being built at Carnegie's Las Campanas Observatory in Chile.

The Academies' highly anticipated report, *Pathways to Discovery in Astronomy and Astrophysics for the 2020s*, was the result of its survey of the astronomy and astrophysics community regarding strategic goals and initiatives for the next 10 years. The recommendation detailed that building an extremely large telescope "is absolutely essential if the United States is to maintain a position as a leader in ground-based astronomy."

In the Academies' survey, the GMT was evaluated as a core partner of the U.S. ELT program, which was viewed as a visionary initiative that will enable collaborative, inclusive, and transformational research in nearly all areas of astrophysics—from understanding the fundamental nature of the universe to the search for life on other worlds.

Launched in December 2021, the James Webb Space Telescope will complement this upcoming generation of extremely large ground-based telescopes. Several Carnegie



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Giant Magellan Telescope

astronomers are among the first to lead projects using data from JWST observations. Their investigations span the breadth of expertise at our Observatories and Earth and Planets Laboratory—from exploring the makeup of exoplanets to revealing the secrets of ancient galaxies and probing cosmological questions.

Toward a Unified Vision of Biology

In November 2021, Carnegie named pioneering microbiome specialist Margaret McFall-Ngai the inaugural director of a newly launched division designed to unify our longstanding expertise in developmental biology, plant biology, and global ecology under one strategic vision.

McFall-Ngai is a recognized thought leader regarding the cornerstone role microbiology plays in the life sciences. She is ideally positioned to guide Carnegie's division

of Biosphere Sciences and Engineering as we prepare for a leap forward in our understanding of life on this planet.

Thanks to recent advances in research tools and techniques, biologists are now capable of linking genomic information not just to the synthesis of molecules that comprise our physiological functions—knowledge Carnegie scientists were crucial to elucidating over the last half-century—but also extending these investigations to the community interactions that shape both human health and ecosystem resilience.

Carnegie's impressive foundation in expertise across scales—from molecular biology to global ecology—and mastery of working in a broad swath of biological systems—from microbial mats to coral reefs and farmland to coastal waterways—position Biosphere Sciences and Engineering for leadership on some of the greatest challenges facing humanity today.



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